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LATERAL FRONTAL SLOW POTENTIAL SHIFTS PRECEDING LANGUAGE ACTS I--ETC(U)  
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LATERAL FRONTAL SLOW POTENTIAL SHIFTS PRECEDING  
LANGUAGE ACTS IN DEAF AND HEARING ADULTS

J. F. HOUSE

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Lateral Frontal Slow Potential Shifts Preceding Language  
Acts in Deaf and Hearing Adults

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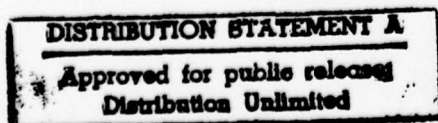
Naval Health Research Center

San Diego, California

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Suggested Running Title: Slow Potentials in Language Acts

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## Abstract

Slow potential EEG shifts (SPSs) recorded over Broca's area and the paired contralateral site preceding cued language acts have been reported to identify the language-dominant hemisphere. This method was applied to the comparative study of 10 hearing adults and 10 adult prelingually deaf persons whose first learned language was American Sign Language.

Volunteers performed both language and non-language acts in both oral and manual expressive modes. The hearing group showed no lateralized SPS, failing to replicate previous reports. The deaf group showed a nonsignificant trend opposite in laterality to that of hearing groups in previous reports.

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## Lateral Frontal Slow Potential Shifts Preceding Language

### Acts in Deaf and Hearing Adults

John F. House and Paul Naitoh

Several early electroencephalographic (EEG) studies attempted to establish EEG correlates of normal (Knott, 1938; Travis & Egan, 1938) and abnormal (Travis & Knott, 1935) speech and language activity. The spontaneous EEG, particularly in the alpha bandwidth, continues as a tool for such studies supplemented by averaging techniques. The spontaneous EEG and evoked potential studies have produced interesting but contradictory reports. While such studies sometimes appear to be failures in replication, results often are simply not comparable due to disparate methodologies.

"Backward averaging" of lateral EEG preceding language-related motor activity was unsystematically attempted as early as 1967 (Ertl & Schafer, 1967; Schafer, 1967). Since then, several studies of lateral-frontal EEG preceding speech acts have been published (McAdam & Whitaker, 1971a and b; Whitaker, 1971; Morrell & Huntington, 1971, 1972; Grozinger, Kornhuber, Kriebel, & Murata, 1972). While most of these studies have reported lateral asymmetry associated with speech but not with control non-speech behaviors, there are some disparities of method and with respect to some of the results. A more serious problem was presented by Grabow and Elliott (1974) who attempted and failed to replicate the findings of McAdam and Whitaker (1971a).

The slow potential shift (SPS) literature has been less voluminous but somewhat more comparable across studies with more consistent results. Investigators of lateral-frontal sites comparing Broca's area and its

contralateral homologue have reported greater negativity of SPS over the language-dominant hemisphere defined as left hemisphere in most right-handed persons (Butler & Glass, 1971, 1974; Kostandov & Briling, 1973; Low, Wada, & Fox, 1973, 1974; Zimmerman & Knott, 1974). Low et al. (1973, 1974) reported verification of laterality of the language-dominant hemisphere by intra-carotid sodium amytal injection. Butler and Glass (1974) reported that their visual vigilance control condition also "lateralized." The remaining investigators found lateral symmetry of SPS in non-language control tasks. The success of this technique has led to its use in the etiology of stuttering (Zimmerman & Knott, 1974).

The anatomic-physiological basis of language in the deaf has been questioned at least since Wernicke's (1874) speculations on the development of language in persons born deaf. In the majority of American deaf households "Ameslan" (American Sign Language), a visual-manual tridimensional language with its own linguistic structure, is the preferred medium of communication (supplemented by finger spelling). Deaf children reared in such households acquire this language in a developmental sequence paralleling the hearing child's acquisition of aural-oral language (Klima & Bellugi, 1974). There is evidence that tridimensional visual analysis of position and shape is for hearing persons a "specialty" of the non-speech-dominant hemisphere (Benton, 1969); in the deaf person "raised signing," it is just these properties handled by non-speech-dominant hemispheres which make up the key factors of the language (Stokoe, 1960; Stokoe, Casterline, & Croneberg, 1965).

There is a small literature on dysphasia in deaf adult persons suffering stroke, tumor, and others (Grasset, 1896; Critchley, 1938;

Leischner, 1943; Tureen, Smolik, & Tritt, 1951; Douglas & Richardson, 1959; Sarno, Swisher, & Sarno, 1969). Only right-handed cases have been reported. These reports vary markedly in etiology, sophistication of investigation, and patient history (e.g., etiology and onset of deafness, history of language acquisition), but they have suggested considerable similarity in the neuroanatomical substrates for aural-oral and visual-manual language. However, as Sarno et al. (1969) pointed out, the lesion studies must be "substantiated by objective methods." This is particularly true since none of these reports deals with the confounding effect of gestural dyspraxia in such cases (Goodglass & Kaplan, 1963).

The results to date have not supported the view that the development of cerebral functional lateralization is alike between normally hearing and prelingually deaf persons. Neville (1976) demonstrated that a visual evoked potential effect identifying the "non-dominant" right hemisphere in hearing children in a visual matching task showed the opposite hemispheric lateralization among deaf children reared in American Sign Language by deaf parents, and no reliable lateralization among deaf children raised in hearing homes. McKeever, Hoemann, Florian, and Van Deventer (1976) studied tachistoscopic split-field recognition of written English words and letters versus pictures of manual signs and manual alphabet letters, in deaf and hearing adults who were fluent in American Sign Language. Their hearing group dissociated English versus manual language stimuli into left and right hemisphere respectively for better performance. Their deaf group showed no such lateral specialization. Both studies suggest that rearing via visual tri-dimensional sign language is associated with different CNS electrophysiological correlates of behavior, as compared to auditory language or absence of language during rearing.



McGuigan (1971), studying electromyographic response of deeply relaxed persons during mental arithmetic, found an unpredicted difference among right-handed hearing and right-handed deaf volunteers. Both groups increased vocal muscle tone (the deaf had had extensive oral training). The right arm of hearing persons increased in muscle tone. For the deaf, their left "non-writing" arm showed the increase. Kinsbourne (1972) developed a model to explain aversive eye movements during mental tasks which may pertain to this odd finding. This model proposes that activation of a hemisphere involves not only structures directly involved in the task at hand, but also an increase in generalized tonus in the rest of the hemisphere--in particular for expressive motor acts, such areas as the frontal eye fields (thus yielding the involuntary eye movements) or possibly in McGuigan's case the primary motor strip. This could explain the anomalous left-arm result in the deaf as an expression of right-hemispheric lateralization of language functions suggested by the Neville (1976) and McKeever *et al.* (1976) studies.

The present study investigated the cerebral organization of expressive language among prelingually deaf adults reared in American Sign Language in comparison to hearing adults. The slow potential shift technique discussed above was selected as the index of cerebral lateralization of function.

#### METHOD

Subjects were 20 unreimbursed adult volunteers, strongly right-handed (Annett, 1967), in good health. There were two groups, each with 7 males and 3 females. Sex was matched due to possible sex differences in SPS related to anxiety (Knott & Peters, 1974) or in degree of speech lateralization (Levy, 1969; McGlone & Davidson, 1973; Waber, 1976).



Ten volunteer students from the U.S. Naval School of Health Sciences, San Diego, California (age  $\bar{x}$  20.9, S.D. 3.5), were studied as hearing controls. Ten volunteers (age  $\bar{x}$  34.8, S.D. 16.3) were deaf (either absolute or profound hearing loss) since birth. All of the deaf group had been reared with American Sign Language as the mode of communication by parents fluent in that language. Apart from deafness, no volunteer had any history of neurological defect, illness, or trauma. No subjects had any knowledge of SPS research, but all knew what an EEG was.

Scalp EEG SPS recording used Beckman "Biopotential" electrodes attached via collodion-soaked gauze pads and were recorded on a Beckman Type R dynograph. Electrodes over clear skin were attached with adhesive discs. Sites recorded were vertex ( $C_z$ ) and lateral-frontal sites overlying Broca's area (pars triangularis, inferior frontal gyrus, verified by autopsy on an available cadaver at a Naval hospital) and its contralateral homologue. Placements were thus essentially those of previous reports (McAdam & Whitaker, 1971a; Low *et al.*, 1973, 1974; Grabow & Elliott, 1974; Zimmerman & Knott, 1974). Linked mastoid sites served as EEG reference. The impedance of each electrode was below 10 K $\Omega$ , matched as closely as attainable per subject. Scalp EEG and mastoid sites were pretreated with atropine sulfate iontophoresis (Picton & Hillyard, 1972) to temporarily eliminate electrodermal artifact; lateral asymmetry in electrodermal activity has been reported from noncephalic sites (Varni, 1975).

Eye movements (EOG) were recorded separately for each eye. The "active" electrodes were set above and medial to each eye, while the "references" were below and lateral, equidistant across the pupil at a 45° angle to the vertical. Each subject's recording included a series of eye

movements of  $20^\circ$  and of  $2^\circ$  of arc in vertical, diagonal, and horizontal tracking of a spot of light. Comparison of the two EOG channels thus allowed scaling and editorial control of not only vertical but, more importantly, of horizontal eye movement. Horizontal gaze has been linked to language-related acts (Kinsbourne, 1972; Gur, Gur, & Harris, 1975). Antero-lateral SPS recording is vulnerable to lateral gaze shifts, requiring explicit control not documented in prior reports. Atropinization fortunately is less necessary in the periocular region (Picton & Hillyard, 1972) as risk of pupillary dilation precluded such use.

Preamplification couplers on the EEG channels were modified to 8.0 sec time constants. The EOG channel time constants were 3.0 sec. The effective high-frequency response of the system was set at 27 Hz, 3 dB roll-off. External filters set at 0.02 and 40 Hz bandpass provided auxiliary filtration for both recording and playback. A 7-channel FM tape recorder stored EEG and EOG data, plus one channel of trigger and stimulus event signals generated by the logic circuitry controlling stimulus presentation. A time code generator occupied the remaining tape channel. Simultaneous paper recording provided for off-line editing. Two judges independently edited records, eliminating trials containing eye blink, machine artifact of any sort, or eye movements greater than  $2^\circ$  of arc in any direction. Only trials scored acceptable by both judges were used. Of 40 trials presented per set, an average of 13 per set survived editing. Each set was repeated three times per day. No significant (0.05) difference in N trials by group, by subject, by condition, or by time of day was observed post-editing.

Calibration for data channel comparison was in two steps: (1) a  $10 \mu\text{V}$

10 Hz sine wave was simultaneously fed to all recording channels and gains were fine-adjusted via oscilloscope display to be "equal" after eyeball inspection, and (2) this same signal was recorded on each subject's tape with all equipment settings exactly as used that day. The data analysis program<sup>1</sup> used to digitize, average, and score the data automatically measured this calibration signal and corrected for between-channel gain differences to provide the final calibration step. This same signal permitted computer calculation of SPS amplitudes.

Subjects were seated in a semi-reclined adjustable chair in a sound-treated room, a folded towel serving to steady the head without neck muscle tension. Gaze was fixed straight ahead on a black "x" 2.5 cm high and wide in the center of a white screen 90 cm high x 150 cm wide, 2.7 m from the face. All subjects wore padded earphones carrying "white noise" to prevent hearing persons from detecting equipment sounds; the earphones also served as base for a small carbon microphone mounted on a lucite wand, positioned 1 cm below and 2 cm before the mouth. Sixty cm above and 0.3 m behind the chair was a Grass PS-2 stroboscopic light source (intensity 4, minimum duration), which presented the warning stimulus (S1) as a full-field flash. In the same position was a Kodak Carousel sound-treated projector; the imperative stimulus (S2) was a blue disc 7.5 cm in diameter projected onto the central fixation point and terminated by the volunteer's response. A photocell mounted on the edge of the projection screen relayed stimulus events to the polygraph.

Each volunteer passively observed one set of 40 trials, maintaining eye fixation, for accommodation. Blinking was discouraged. Each trial consisted of a 4-sec intertrial interval (ITI), then S1, a 1500 msec



interstimulus interval (ISI), and S2 onset. After 4 sec, S2 terminated and the next ITI began. Each subject then performed a series of sets of 40 trials under each of six conditions of instructed operant responses to S2; response immediately terminated S2 and began the next ITI. Each "run" of six conditions was as follows:

1. MN: Manual Nonverbal response; upon S2, both hands were simultaneously raised vertically 10 to 15 cm from a resting position on a lap board; this act released two contact switches upon which the hands rested between trials, thus terminating S2.
2. MVS: Manual Verbal response, "Start again"; upon S2, the American Sign Language phrase, "start again" was performed, which required a simultaneous bilateral hand movement initially identical to MN; hearing volunteers performed this as a rote instructed motor response without awareness of its verbal significance, as confirmed by post-experiment inquiry.
3. MVN: Manual Verbal response, Name; upon S2, deaf volunteers raised both hands and performed their "name-sign," i.e., the visual-manual symbol by which each was conversationally addressed by others. (Persons whose name-sign used only one hand were asked to do it with both hands to retain motor symmetry.) Hearing volunteers have no such response; hence their MVS data were used again as an estimate of non-language manual response.
4. ON: Oral Nonverbal response; upon S2, the response was phonation of the sound "Sss . . ."; a voice-operated relay detected oral responses and terminated S2.
5. OVS: Oral Verbal response, "Start again"; upon S2, the response was to orally produce the words, "start again"; the initial sibilant "Sss" phonation was chosen to parallel that of ON.



6. OVN: Oral Verbal response, Name; upon S2, each person spoke the name by which they were most often conversationally addressed by others.

The entire task sequence was fixed for this study and its complete "run" required slightly over 1 hr. Instructions, including practice responses, were given between conditions as was 1 min of rest. One run was completed in the morning; 1½ hrs were allowed for lunch. A second and third run with ½-hr break followed in the afternoon. Electrodes for EEG remained in place all day unless reset (e.g., because of resistance change due to mechanical stress). The chamber was illuminated.

After editing, acceptable trials were digitized and assembled into averages for each person x channel x condition x run. The epoch for each average was 4 sec, beginning at a trigger signal (undetectable to subjects) 1500 msec prior to S1 and ending 1 sec after S2. Fig. 1 presents one condition averaged by channel over a group, illustrating event sequence. Baseline for SPS measure was set at the mean value of the 16 msec preceding S1. Scores were computed for SPS with reference to this "zero" baseline by taking the mean voltage value of the ISI S1 to S2. (See page 11a for Fig. 1)

Mean lateral voltage differences (Left minus Right) arising in nonverbal conditions within subjects were subtracted from lateral differences arising during corresponding verbal conditions. This should eliminate asymmetries not specific to verbalization. The results of Grabow and Elliott (1974) argue that unless subjects deliberately make lateral tongue shifts, glossokinetic potential effects are symmetrical and thus controllable by the present design. As a further safeguard, subjects were required to maintain separation of tongue and palate during ISI of oral trials by mouth breathing except during response.

Fig. 1  
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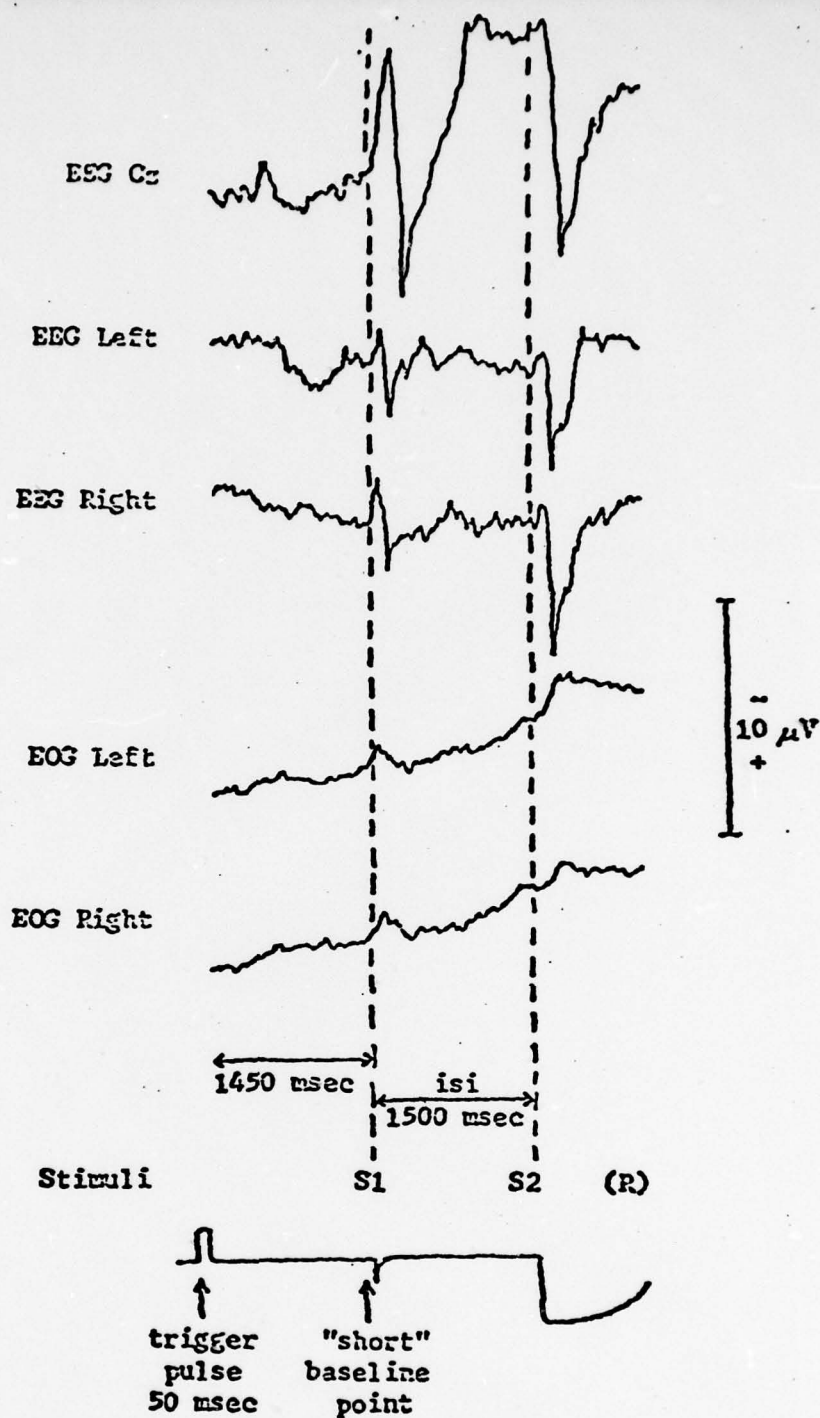


Fig. 1

Figure 1. Example of Event sequence. Illustration from data of hearing group. Each channel average is of all hearing subjects, all trials of manual nonverbal response. All averages to scale except stimuli; polarity, negative up.

## RESULTS

Vertex Data

(Table 1  
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Data from  $C_z$  were examined by groups and conditions. Table 1 entries depict mean digitized voltage values in microvolts, recorded from the vertex, for the S1-S2 interval. Evaluation of between-group differences over all trials ( $t = 0.799$ ,  $df\ 18$ ,  $p > .05$ ) yielded no reason to conclude group differences. By-condition comparisons between groups were made, with the Dunn-Bonferroni adjustment for multiple related  $t$ -tests (Dunn, 1961); no significant differences were found. Vertex data were also examined by "run," i.e., first, second, and third set of trials per day (not tabulated here); no significant differences were found. [Table 1, see pg 12a]

Laterality Data

The recording design provided that horizontal eye motion registered as nonparallel activity on EOG channels, while vertical eye motion caused parallel EOG tracings. Therefore, the EOG channels were averaged in the same manner as EEG data on accepted trials; algebraic differences between EOG channel scores represented net horizontal eye-motion activity (plus variance due to "noise" such as frontal polar EEG). To assess the success with which horizontal eye motion had been eliminated as a source of artifact, product-moment correlations were calculated for each group, across all trials of all subjects, between left minus right EEG scores for each average and the corresponding left minus right EOG scores. For the hearing group the correlation was  $r = 0.11$ , for the deaf  $r = 0.10$ . Testing for the significance of the difference between correlations and the significance of each alone (Ferguson, 1959) showed neither significantly different from zero nor from each other.

TABLE 1  
Vertex Mean Voltage Values Over ISI,  
Averaged by Groups Across All Trials within Condition

Set	Hearing		Deaf		All Subjects	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
MN	-4.80	4.16	-4.76	3.07	-4.78	3.55
MVS	-2.58	2.89	-5.54	5.16	-4.06	3.45
MVN	*	*	-5.85	4.93	-4.22*	3.91*
ON	-2.80	1.73	-3.82	2.35	-3.31	2.08
OVS	-2.29	2.74	-2.24	5.46	-2.40	4.13
OVN	-2.35	3.23	-2.81	5.28	-2.58	4.26
All trials	-2.84	1.98	-4.15	2.87	-3.70	3.66

\*Hearing group did not perform MVN: "All Subjects MVN" estimate based on "hearing MVS" data.



For lateral SPS comparison, the difference score (Left minus Right) was calculated for each subject for each average of each set of trials. The difference (L-R) for nonverbal tasks was subtracted from the difference (L-R) for the corresponding verbal task. The remainder represented lateral difference specific to verbal task (e.g., MVS-MN, difference during Manual Verbal "Start Again" response condition minus difference during Manual Nonverbal condition). Fig. 2 depicts group mean and standard deviation data for scores derived in this manner for all conditions over all task runs each day. [See page 13a for Fig. 2]

Fig. 2  
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The zero value on the ordinate indicates a lack of difference in lateral EEG score between verbal and nonverbal conditions, regardless of within-condition laterality. Analysis of variance for mixed model repeated measures design (Winer, 1962) yielded no significant effects by group, condition, or interaction. Table 2 presents the analysis of variance for all subjects over all trials. [See page 13b for Table 2]

Table 2  
about  
here)

The analysis of variance was repeated in the following ways. First, the baseline "zero" for SPS measurement was extended from the mean value of the 16 msec preceding S1 to the mean value of the 1472 msec preceding S1. Secondly, measurement of ISI mean voltage was recomputed excluding 320 msec of data following S1 and also 96 msec of data preceding S2. Including the above ANOVA, this produced a 2 x 2 set of analyses, short vs. long baseline by full vs. partial ISI. All analyses led to the same result. Omission of the first run of the day and ANOVA based on afternoon runs only likewise led to acceptance of the null hypothesis.

Since selection for right-handedness leaves perhaps 10% risk of other than clear left-hemisphere dominance for language (Branch, Milner, &

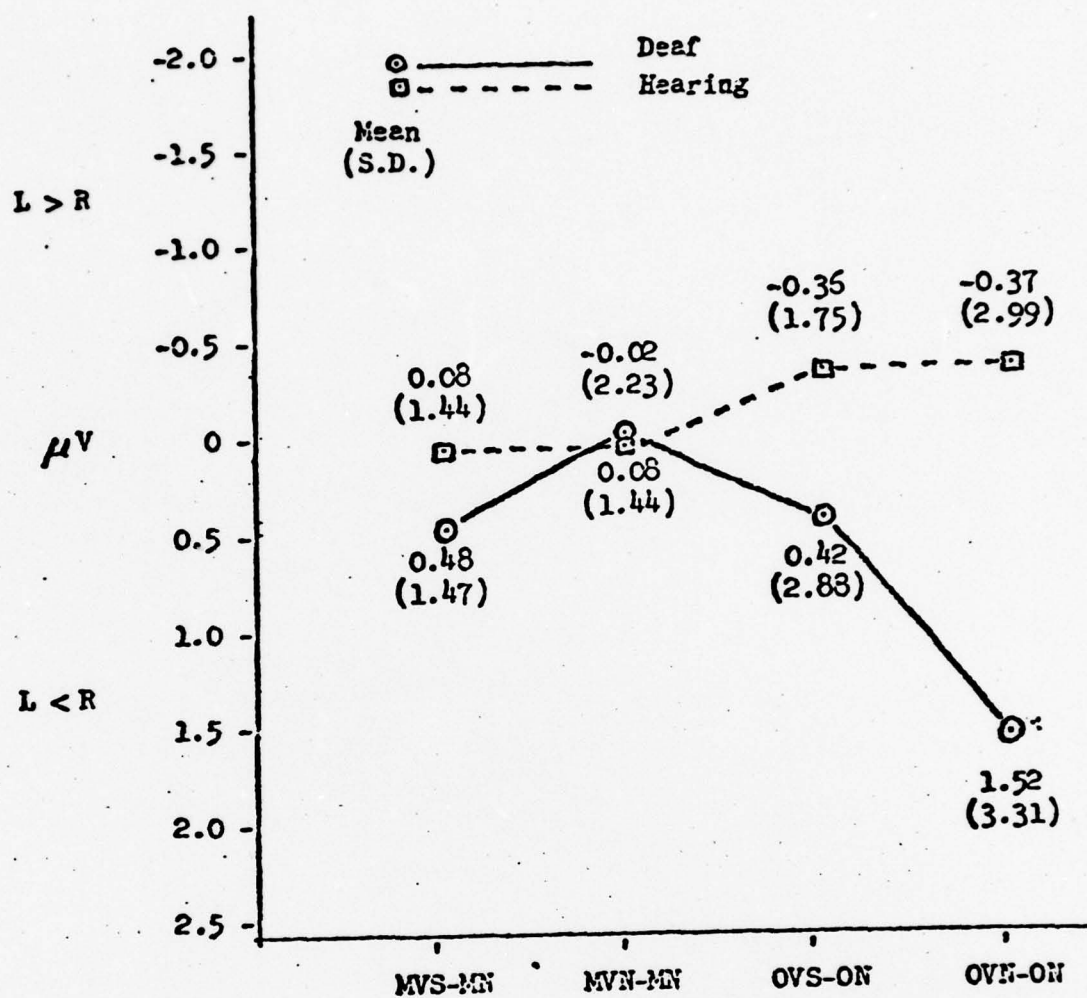


Figure 2. Short Baseline, Whole ISI. (L-R verbal) minus (L-R nonverbal) scores, by task, by group. MVN for hearing group uses MVS task/data.

TABLE 2

Analysis of Variance; All Subjects, All Trials,  
[(L-R) Verbal-(L-R) Nonverbal] Mean Voltage over S1-S2 Interval

Source of Variance	Subjects	df	MS	F
Between Subjects	140.61	19		
Groups (A)	10.95	1	10.95	1.521
Subjects Within Groups (SsW)	129.66	18	7.20	
Within Subjects	268.25	60		
Condition (B)	3.99	3	1.33	0.272
(B) x (A)	10.81	3	3.60	0.737
(B) x (SsW)	264.26	54	4.89	

Rasmussen, 1964), the possibility existed that an extreme atypical case per group could have clouded the results. The measure which showed the greatest group difference (OVN-ON) was tested using a rank test for independent samples (Ferguson, 1959), a nonparametric test relatively insensitive to outlying cases. The deaf group rank sum was 121, hearing 89, yielding  $z = 1.21$ , nonsignificant.

Lateral (L-R) difference data were examined by condition, by subject within groups using Friedman's two-way analysis of variance by ranks (Friedman, 1937). For the deaf group,  $\chi^2$  was 4.99 for df 5; for the hearing group,  $\chi^2 = 1.76$  for df 4. Both cases failed to reject the null hypothesis that lateral asymmetry of SPS did not differ between conditions. No significant difference therefore appeared within either group between verbal and nonverbal conditions in degree of associated lateral SPS asymmetry.

For each volunteer, the measure (L-R) of SPS balance between lateral sites was averaged over all trials per condition. Table 3 \* presents the lateral polarity relationships for each condition within each group, in terms of number of subjects with greater electronegativity in the direction indicated. Differences of less than 0.5  $\mu V$  mean difference during ISI summed over the three runs were assigned a value of "no difference." As suggested by ANOVA, the group distributions appear similar to each other and fairly evenly distributed between the hemispheres. Using  $\chi^2$  estimate of goodness of fit, neither group's L > R distribution across conditions varies significantly from a "no effect" expectation of five cases per cell (hearing,  $\chi^2 = 1.00$ , df 4,  $.98 > p > .95$ ; deaf,  $\chi^2 = 3.20$ , df 5,  $.70 > p > .50$ ). Clinical and experimental evidence suggests an a priori basis

(Table 3  
about  
here)

(\* See page 14a for Table 3)



TABLE 3  
Lateral Polarity Relationship, Condition by Group,  
In Terms of N of Subjects  
Showing Greater Negativity in Indicated Directions

Set	Hearing			Deaf		
	L > R	L = R <sup>1</sup>	L < R	L > R	L = R <sup>1</sup>	L < R
MN	3	1	6	4	1	5
MVS	4	3	3	2	1	7
MVN	*	*	*	5	0	5
ON	5	1	4	4	1	5
OVS	5	1	4	4	1	5
OVN	5	2	3	3	2	5

<sup>1</sup>L = R, symmetry, scored when mean  $\mu$ V value over S1-S2 interval was less than 0.5.

\*Not performed by hearing group.

for setting expected  $L > R$  cell frequency in oral verbal conditions at 80%, or  $N = 8$ . Observed values fit this model less well but do not differ from it significantly (hearing,  $\chi^2 = 3.25$ ,  $df\ 4$ ,  $.70 > p > .50$ ; deaf,  $\chi^2 = 7.325$ ,  $df\ 5$ ,  $.20 > p > .10$ ). Extension of expected language-related asymmetry to the manual verbal condition for the deaf group, likewise set at 80% left dominance per normal speakers, yields a  $\chi^2 = 11.15$ ,  $df\ 5$ ,  $.05 > p > .02$ .

#### DISCUSSION

These results did not support the expectation based on earlier studies (Butler & Glass, 1971, 1974; Kostandov & Briling, 1973; Low et al., 1973, 1974; Zimmerman & Knott, 1974) that lateral-frontal SPS asymmetry preceding forewarned cued language acts would serve as an index of hemispheric dominance for speech. Alteration of baseline for measurement did not alter this outcome. Restriction of the measurement epoch to reduce possible influence by visual evoked response to S1 or pre-response motor preparation was attempted as described. This procedure more closely approximated the measurement epoch reported successful by Kostandov and Briling (1973). Results for the shorter epoch were also negative.

The graphic data published by Zimmerman and Knott (1974) were visually inspected for comparison with the method of analysis of the present study. Their 5 normal speakers would by the present method have been scored  $L > R$  four cases,  $L < R$  one case for their verbal non-speech "expectancy" task. In the oral verbal response task directly comparable to the present study, their normal speakers would have scored three cases  $L > R$ , one case  $L < R$ , one case  $L = R$  or marginally  $L > R$ . It thus appears that the discordance of results between that study and the present one is not a function of the difference in approach to measurement.

The Butler and Glass (1974) study using the contingent negative variation (CNV) paradigm was not unequivocally positive in that lateral asymmetry appearing in language-related tasks also appeared in a control task. A suggested explanation in that report was that the language tasks induced a verbal-mediation set which carried over to the control task (visually monitoring a serial display of zeroes for uniformity). Such serial-order effects are a problem of within-subject repeated measures designs (Johnson & Lubin, 1972). The argument, then, is that their control condition asymmetry is correctly indexing activity of the language-dominant hemisphere brought on by treatment carry-over, and their paper supports rather than disconfirms the use of lateral SPS as a measure of hemispheric lateralization of function. The carry-over thesis though empirically testable, whatever its merits, does not explain the present case. Here, the fixed task order within runs was designed to present nonverbal tasks known to yield symmetrical SPS results first, then proceed to increase task demands with verbal tasks given last. Carry-over effects of nonlateralized tasks presumably should be negated by the demand for overt production of a lateralized response; Low *et al.* (1973, 1974) have reported success with just such a design.

The most salient differences between the present and previous CNV paradigm studies of language-related SPS asymmetry lie in the explicit control of horizontal eye movement and in the suppression of electrodermal activity via atropine iontophoresis of EEG active and reference sites. The recording sites, tasks, and measurements used each match or closely approximate those of one or more of the studies reporting success in demonstrating lateralization.



The most similar work was that of Low et al. (1973, 1974) in design, technique, execution, and measurement. Besides the factors of horizontal EOG and electrodermal response control, the major difference from that study appears to lie in the treatment of first-run data. Low et al. reported retesting subjects whose initial data were not clear-cut; retesting a second or, if necessary, a third time was said to eliminate anxiety or accommodation effects obscuring first testing. The necessity of bringing deaf subjects from a distance prompted adoption of a design using retests within one day of work. Systematic effects suggesting "first-run anxiety" could not be demonstrated via C<sub>z</sub> CNV, nor by number of trials per run acceptable to editing. A policy of culling serially through the sets of the day's work of each subject until a clear-cut example of asymmetry appeared did provide a "positive" result. This is capitalizing on random variation, however. Simple exclusion of each subject's morning trials did not alter the negative results of the present study.

The present results appear to present an instance contrary to reports of successful use of lateral-frontal SPS activity as a noninvasive index of a state of lateralized activity in the cerebral hemispheres subserving speech and language functions. Stringent control of horizontal EOG components and electrodermal activity in this study were directed at the assumption to date in this literature that the dependent EEG variables represent events specific to the neocortex beneath the electrodes (i.e., Broca's area). This negative result underscores Low et al.'s (1974) remark that it is possible that some covariate response instead is contributing to the positive reports.

Finally, the possibility remains that the present case is not a true



disconfirmation but an atypical sampling of hearing subjects (as seen in Table 3 where hearing subjects did not show an expected hemispheric asymmetry). Until further research clarifies the matter, however, it appears prudent to suggest that asymmetrical lateral SPS as an index of cerebral lateralization of function is not yet established with sufficient reliability to warrant confident application to research questions and for clinical uses requiring such an index. The present failure to replicate suggests that the trend to such applications be curtailed pending further research into the reliability and validity of such techniques.

## FOOTNOTE

<sup>1</sup>The data analysis program for the PDP-12 computer was designed and composed by Drs. Glenn Wilson, Jerry Wicke, and Karl Syndulko while in the UCLA laboratory of Dr. Donald B. Lindsley; Drs. David Seales and Karl Syndulko provided necessary program modifications for use at the Naval Health Research Center.

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20. Abstract (continued)

group showed no lateralized SPS, failing to replicate previous reports. The deaf group showed a nonsignificant trend opposite in laterality to that of hearing groups in previous reports.

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